Quick Start Guide to *Increase Data Center* Energy Efficiency

Key Best Practices

Optimize the Central Plant

Typically, a central cooling plant and air handlers are more efficient than distributed air conditioning units. Begin with an efficient water cooled variable speed chiller, add high efficiency air handlers, low-pressure drop components, and finish with an integrated control system that minimizes unnecessary dehumidification and simultaneous heating and cooling.

Use temperature resets to allow use of medium-temperature chilled water (55 degrees Fahrenheit or higher). Warmer chilled water improves chiller plant efficiency and eliminates the need for the chiller during many hours of operation (tower cooling).

Free Cooling

Can you design your data center for free cooling? Can you retrofit the outside air supply? Can you retrofit a water side economizer (use cooling tower to pre-cool return "chilled" water)? It is all about humidity and temperature.

Right Sizing

When the ultimate load is uncertain, data center cooling systems are often oversized and operate at inefficient part loads. Therefore, it makes sense to pre-install fixed elements such as ducts and pipes, but design for modular growth of the mechanical equipment. Include variable speed fans, pumps and compressors. Right size all your plant equipment—overbuilding in advance of actual needs makes many subsystems operate inefficiently.

Use Liquid Cooling of Racks and Computers

Water is 3,500 times more effective than air on a volume basis; so it cools servers and appliances more efficiently than air conditioning! Today, you can purchase liquid cooled racks. Manufacturers are prototyping liquid-cooled computers as well.

People are Key

Facilities and IT staff bring different perspectives to create better solutions when it comes to data center energy efficiency. Ask your counterpart to lunch so you can begin to learn about their challenges and explain your own.

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GSA

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How To Start

Commit to Improved Design and Operations

- Benchmark existing facilities
- Document design intent
- Introduce energy optimization early in the design process
- Use life-cycle total cost of ownership analysis
- Continuously monitor energy and environmental conditions
- Re-commission as a regular part of maintenance
- Empower IT and facilities staff to work together

Learn More

You can get more information about the following topics at the websites listed below:

- Air management
- Right-sizing
- Central plant optimization
- Efficient air handling
- Free cooling
- Humidity control
- Server efficiency
- Liquid cooling
- Improving power chain
- UPSs and equipment power supplies
- On-site generation
- Designing, measuring & optimizing processes

DOE Save Energy Now Tools and Resources:
www.eere.energy.gov/datacenters

Energy Star® Program:
www.energystar.gov

Lawrence Berkeley National Laboratory (LBNL):
http://hightech.lbl.gov/datacenters

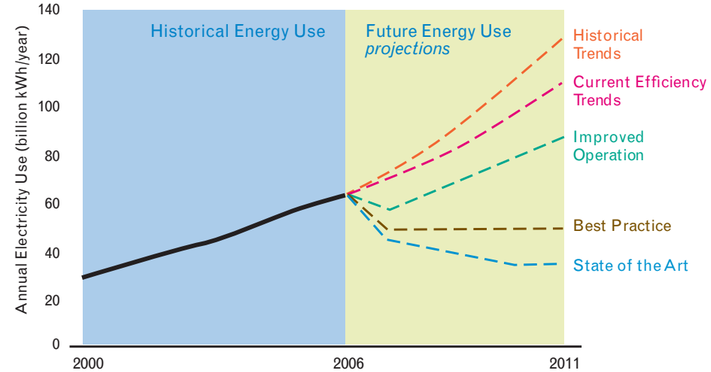
ASHRAE Data Center Technical Guidebooks:
http://tc99.ashraetcs.org

A Problem That You Can Fix

Data Center energy efficiency is derived from addressing BOTH your hardware equipment AND your infrastructure.

Less than half the power used by a typical data centers powers its IT equipment. Where does the other half go? To support infrastructure including cooling systems, UPS inefficiencies, power distribution losses and lighting. Why does this matter?

- By 2012, the power costs for the data center equipment over its useful life will exceed the cost of the original capital investment.
- By 2020, the carbon footprint of data centers will exceed the airline industry
- With today's best practices, 20-50% energy savings are possible, extending the life and capacity of existing data center infrastructure, avoiding millions of metric tons of carbon emissions, and saving.



Source: Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431, US EPA, August 2, 2007

The energy used by a single rack of emerging generation servers (20kW plus air-conditioning) each year is equivalent to the energy required to drive an average car coast-to-coast about 300 times (25 miles per gallon).

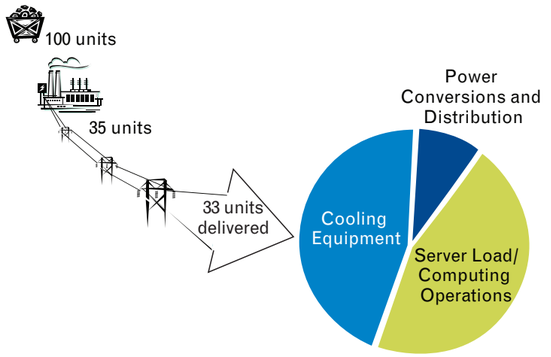
—Evan Mills, (Lawrence Berkeley Lab, 2008)

A Quick Start to Energy Efficiency

Data Center Energy Efficiency • Increase Your Data Center Energy Efficiency • Increase Your Data

Energy Usage in Data Centers

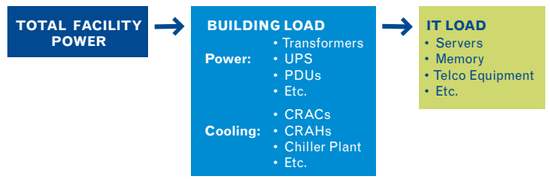
How Energy Gets to Your Servers



Power plant inefficiencies and transmission line losses mean that just 15% of source energy is typically available to your servers. Because support infrastructure typically consumes approximately half of site energy, improvements in IT efficiency (e.g. server virtualization, consolidation, storage and network gear) yield a 2:1 ratio in total energy savings. Additionally, the following key changes to the on site power chain presents substantial savings opportunities:

- Increase distribution voltage
- DC distribution
- Improve equipment power supplies
- Improve uninterruptible power supplies and transformer efficiency
- Monitor energy at all levels

High Level Facility Metrics



$$\text{Power Usage Effectiveness } \textbf{(PUE)} = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}}$$

$$\text{Data Center Infrastructure Efficiency } \textbf{(DCiE)} = \frac{1}{\text{PUE}} = \frac{\text{IT Equipment Energy}}{\text{Total Facility Energy}}$$

NOTE: Improving PUE from 2.0 to 1.6 for a data center with a 2.5 MW IT load yields a 20% energy savings or over $800,000 annual savings at $0.08|kilowatt hour.

Meter, Measure, Manage

Measuring where you are now is a good place to start.

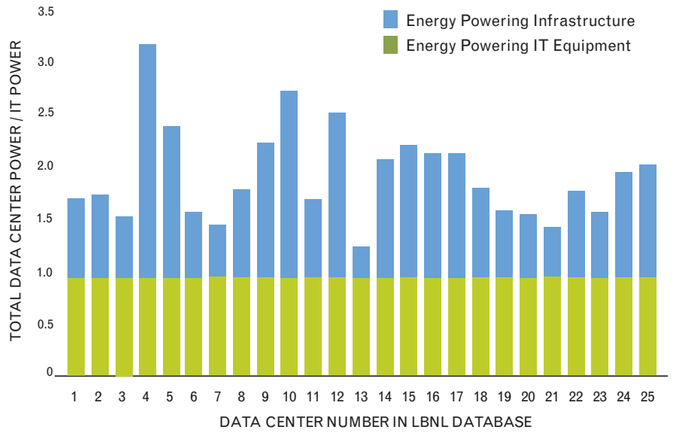
Energy Benchmarking and Continuous Monitoring

Energy benchmarking can be effective in helping to determine the efficiency of your current data center and to identify better-performing designs and strategies. As new strategies are implemented, energy benchmarking will enable comparisons of performance.

The benefits of measuring, monitoring, and taking steps to optimize your energy efficiency also will enable you to extend the life and capacity of your existing data center infrastructure, as well as avoid millions of metric tons of carbon emissions that would result from expansion.

Lowering PUE (Total Facility Energy/IT Equipment Energy)

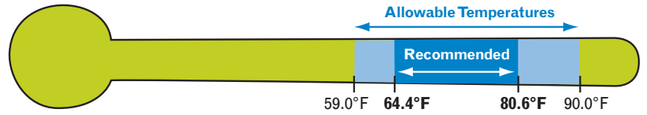
In a study of 25 data centers studied by Lawrence Berkeley National Laboratory (LBNL), roughly 87% of the site energy reaches the IT equipment in the best case, while in the worst case only 33% makes it to the IT equipment. The lower your PUE, the more efficient is your data center infrastructure (power distribution and cooling).



Environment and Airflow

You want to maintain your data centers at a comfortable temperature for your servers (not your staff). Recommended and allowable airflow, filtration, humidity, and temperature limits are all described in ASHRAE publications such as “Thermal Guidelines for Data Center Environments”.

Temperature Guidelines at the Inlet to IT Equipment



Air Management Opportunities

If you feel cold in your data center, you have an opportunity!

- Arrange racks in a hot aisle/cold aisle configuration and isolate the two. Your cold air supply could be in the mid 70s Fahrenheit and your hot air return could be as high as 90–100 degrees Fahrenheit. That is why you want to keep them separate.
- Consider using air handlers (CRAHs) rather than computer room air conditioners (CRACs) for improved performance. Get variable speed fans to match server flow requirements.
- Optimally configure floor tile perforations, plug floor leaks, and install blanking plates in every unfilled rack.
- Continuously monitor temperature, humidity, and underfloor pressure.

Cold and Hot Aisle Layout